

ON A PARASITIC COPEPOD FROM *CEPHALODISCUS*.

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(Plates XVIII., XIX.)

The parasite dealt with in this paper was discovered by Dr. W. G. Ridewood in the course of his investigation of *Cephalodiscus gilchristi* from the Cape Seas, and is briefly referred to in his memoir on that species (*Mar. Invest. S. Africa*, iv., p. 181). At his request I made a preliminary examination of the specimens, and supplied him with a few notes, which are incorporated in the paper referred to. In view of the special interest of the host it seemed desirable to attempt a more complete examination of the material, and I gladly avail myself of the opportunity kindly given me by Dr. J. D. F. Gilchrist of publishing a fuller account.

Most of the specimens which I have examined were found by Dr. Ridewood in the course of his dissection of the *Cephalodiscus*, and I am indebted to him for notes on the circumstances of their occurrence. The other specimens were obtained by searching through some pieces of *Cephalodiscus*-colony which Dr. Ridewood kindly handed over to me for the purpose.

The parasite belongs to the family Ascidicolidæ, of which most of the members are parasitic in the alimentary canal of Tunicata. The fact, however, that the form to which it is most nearly allied, *Enterognathus comatulæ* of Giesbrecht, infests, not a Tunicate, but the Echinoderm *Antedon*, shows that the nature of the parasite in the present case has not necessarily any bearing on the chordate affinities of its host.

In the following account Dr. Giesbrecht's lucid and detailed description of *Enterognathus*\* has been taken as a guide. The

\* Giesbrecht, W., "Mitth. ii. Copepoden. 14. *Enterognathus comatulæ*, ein neuer Darmparasit." *Mitth. zool. Stat. Neapel*, xiv., pp. 61-79, pl. 5, 1900. Dr.

characters and affinities of the new genus which I have found it necessary to establish will be discussed later.

## FAMILY ASCIDICOLIDÆ.

ZANCLOPUS\* CEPHALODISCI, gen. et. sp. nov.

ADULT FEMALE.

(Plate XVIII., figs. 1-8.)

Total length, .55-.62 mm.

The body is stout and maggot-shaped, about  $3\frac{1}{2}$  times as long as wide. The integument is thin and membranous, and the segmentation, especially in the abdominal region, is very obscure. The five thoracic somites are defined by deep constrictions and overlap a little at the sides, but do not form collar-like folds on the dorsal surface as in *Enterognathus*. The thoracic limbs, with the exception of the fifth pair, are articulated on the ventral surface of the body, and are almost invisible when the animal is viewed from above. The head is slightly narrowed in front, and there is a blunt, deflexed rostrum, only visible from beneath (fig. 4). Posteriorly the body tapers gradually, without any marked constriction. The genital somite is very short and is obscurely defined from the somites in front and behind. The openings of the oviducts are lateral in position (fig. 6). The copulatory pore was not observed. The following four somites are rather obscurely separated. The furca (fig. 6) is short, the rami not much longer than wide, each terminating in four short spiniform points directed outwards.

The antennules and antennæ (fig. 4) are short, thick, and not distinctly segmented. The former have each a single terminal seta and a minute seta on the posterior edge.

The mouth-cone (fig. 5) is not very prominent. The lower lip has large lateral lobes. The mandibles each end in a scythe-shaped blade projecting between the upper and lower lips. No trace of a mandibular palp could be detected.

Immediately behind the mouth-cone on each side is a rounded

Giesbrecht has overlooked the fact that *Enterognathus* was figured (but not named) many years ago by Prof. W. C. McIntosh ("Observations on the Marine Zoology of North Uist," Proc. Roy. Soc. Edinburgh, v., p. 611, fig. 5, 1866. The figure is reproduced in the same author's "Marine Invertebrates and Fishes of St. Andrews," 1875, p. 140).

\* From ζαγκλον, a sickle, and πους, a foot, in allusion to the sickle-shaped claws on the thoracic feet of the female.

prominence bearing a single terminal seta (fig. 4, *mx''*). A comparison with *Enterognathus* suggests that these prominences probably represent the second maxillæ. No other mouth-parts appear to be present.

The first four pairs of thoracic feet (figs. 7 and 8) are similar in form. The protopodite is more or less distinctly divided into two segments, of which the distal bears externally, in the first three pairs, a fine seta. The basal part of the exopodite is not distinctly defined from the protopodite; it has, on the inner edge, a minute seta which is largest in the third pair and seems to be absent from the fourth. Distally, the exopodite ends in a sickle-shaped claw, at the base of which a small segment can in some cases be detected. The endopodite is apparently unsegmented, and forms a broadly ovate or nearly circular leaflet, bearing four small blunt papillæ on its distal edge.

The feet of the fifth pair (fig. 6) are large ovate plates attached to the side of the body and pointing backwards. Two very minute setæ were observed on the distal margin of each.

#### MALE IN FIFTH COPEPODID STAGE.

(Plate XIX.)

Total length, .6 mm.

The general shape is *Cyclops*-like, rather elongated, the greatest breadth being about  $\frac{1}{4}$  of the length. The fifth thoracic somite is distinctly narrower than the fourth. The head is about  $\frac{1}{4}$  of the total length, bluntly pointed in front, with a deflexed rostrum as in the female. The pleura of the head-region are not bent inwards as they are in the adult male of *Enterognathus*. The first three somites of the abdomen (fig. 14) diminish successively in length; the fourth is as long as the first, and beneath the cuticle can be seen the division between the fourth and fifth somites of the adult. On the ventral surface of the genital segment are the genital valves (fig. 14, *g.v.*), each truncate posteriorly and bearing two setæ. The furcal rami are longer than in the female and each bears six spines; the inner spine is set on the dorsal surface, the outer one is minute, and the terminal four, of which the second is the largest, are stout and strongly curved outwards.

The antennules (fig. 12, *a'*) have a very delicate external cuticle which does not seem to show any segmentation proper to this stage, but within which can be seen, in the specimen examined, the seven segments of the succeeding (adult) stage. They are beset with fairly numerous simple hairs but no æsthetascs were observed. The

antennæ (fig. 13) are composed of three segments and have two, perhaps three, terminal claws.

The mouth-cone (fig. 12) with the mandibles (*md*) and the maxillary prominences (*mx''*) are exactly as in the female, except that the last-named structures seem to have no terminal setæ.

The first four pairs of feet (figs. 15–17) have the protopodite indistinctly divided into two segments, the distal one bearing, in the first three pairs, a seta on its outer edge. The rami of the first four pairs are each composed of three segments. The distribution of their setæ is shown by the following table, drawn up after the plan followed by Dr. Giesbrecht:—

	Re 1.	Re 2.	Re 3.	Ri 1.	Ri 2.	Ri 3.
1st Foot...	1Se 0Si	0	2Se 1St 3Si	0	0Se 1Si	1Se 3Si
2nd Foot...	1Se 0Si	1Se 1Si	2Se 1St 4Si	0	0Se 2Si	1Se 4Si
3rd Foot...	1Se 0Si	1Se 1Si	2Se 1St 5Si	0	0Se 2Si	1Se 5Si
4th Foot...	0	1Se 0Si	2Se 1St 5Si	0Se 1Si	0Se 2Si	1Se 4Si

The feet of the fifth pair (fig. 14,  $p^5$ ) consist each of two small papillæ, of which the inner is the larger, each bearing a single seta.

#### YOUNGER STAGES.

Specimens of younger stages were occasionally found, but on account of the very indistinct segmentation of the body and limbs it was not possible to refer them to the various larval stages recognised in the Copepoda. The youngest stage observed is represented on Plate XVIII., fig. 9. The total length is about .36 mm. The fourth pair of feet are present as bilobed prominences, and the abdomen is divided into two segments. The first three pairs of feet (fig. 10) have both rami in the form of ovate leaflets, the exopodite with four spiniform points on its distal margin; the second of these points, from the outer side, is larger than the others, and probably represents the single curved claw of the adult female.

#### MODE OF OCCURRENCE AND PROBABLE LIFE-HISTORY.

All the specimens were found in the stomach of adult zooids or nearly full-grown buds. The degree of infection varies in different colonies, or perhaps in different branches of the same colony. In some of the pieces of *Cephalodiscus*-colony which I examined nearly every adult zooid contained one or more parasites, but in other pieces they were much less abundant. The position generally occupied by the parasite in the stomach of its host is shown in

Plate XVIII., fig. 1, but it appears to be a matter of indifference whether the head or the tail is directed towards the anterior end of the stomach.

The adult females are most common, and in every case only a single one of these occurs in one host. The eggs were never observed attached to the body, but isolated eggs, or packets of eggs, were sometimes found free in the host's stomach. The number of eggs deposited at one time appears to vary somewhat. Two packets of two each, two packets of three, and from three to five isolated eggs were observed on different occasions. The diameter of an egg is about .12 mm. Of the larval stages, two, three, or four specimens occurred together in one stomach, accompanied or not by an adult female. No adult male was found, and from the analogy of *Enterognathus* we may assume that this stage is free-swimming.

In several cases it was observed that zooids containing specimens of the parasite had well developed and apparently ripe gonads, so that there would appear to be no "parasitic castration" of the host.

It is not altogether easy to reconstruct from our observations the probable life-history of the parasite. From the relatively large size of the eggs it may be assumed that hatching takes place at a late stage of development. On two occasions specimens in a stage corresponding to that shown on Plate XVIII., fig. 9, were found in the act of escaping from a membranous investment which appeared to present no trace of appendages, and was at first regarded as the egg-membrane. The fact that from two to four of these young individuals always occur together seemed also to suggest that they were hatched *in situ* and had to pass through a free-swimming stage before entering each a separate zooid of the host to become adult females. Further search, however, afforded no evidence of any break in the series of forms, all of them plainly incapable of locomotion, connecting these young stages with the adult. As it seems necessary to assume the existence of a free-swimming stage at some period of the female's life-history (the male is probably, as already stated, free-swimming when adult) there can be little doubt that the earliest stages observed are preceded, as in *Enterognathus*, by a free-swimming stage in which the larvæ pass from one host to another. As in *Enterognathus* also, the females probably emerge temporarily from their hosts when sexual maturity is reached in order to be fertilised by the free-swimming males. On again becoming endoparasitic they each select a host which does not already harbour a parasite.

## SYSTEMATIC POSITION.

Although it has not been possible to ascertain some important characters, such as the condition of the copulatory pore in the female, the parasite described above agrees sufficiently well with the definition of the family Ascidicolidæ as given by Canu,\* and resembles with sufficient closeness several types included therein, to leave no doubt that it must be referred to that family. It appears hopeless, in the present state of our knowledge of the parasitic Copepoda, to look for an exact diagnosis either of the family or of its constituent genera. At the same time the new species is so distinct from any of those hitherto described that it appears impossible to avoid the establishment of a new genus for its reception. In the vermiform, or maggot-shaped, body and non-natatory thoracic feet of the female and in the absence of a brood-sac and of maxillipeds it approaches the genera *Enterocola*, *Aplostoma*, *Enteropsis*, and *Enterognathus*. From all of these except the last it is distinguished (in the female sex) by the strongly-hooked exopodites of the first four pairs of thoracic feet. From *Enterognathus* it differs in the less strongly-marked segmentation of the thoracic region, of which the somites do not overlap dorsally, in the indistinctly segmented appendages, the reduced and palpless mandibles, the vestigial non-prehensile second maxillæ, and in the absence of the first maxillæ. In the last-named character it agrees with *Aplostoma* and *Enteropsis*, differing from both, however, in the structure of the mandible, second maxilla, and thoracic feet, and in many other details.

\* Canu, E., "Les Copépodes du Boulonnais." *Trav. Stat. Zool. Wimereux*, vi., p. 186, 1892.



EXPLANATION OF THE PLATES.

PLATE XVIII.

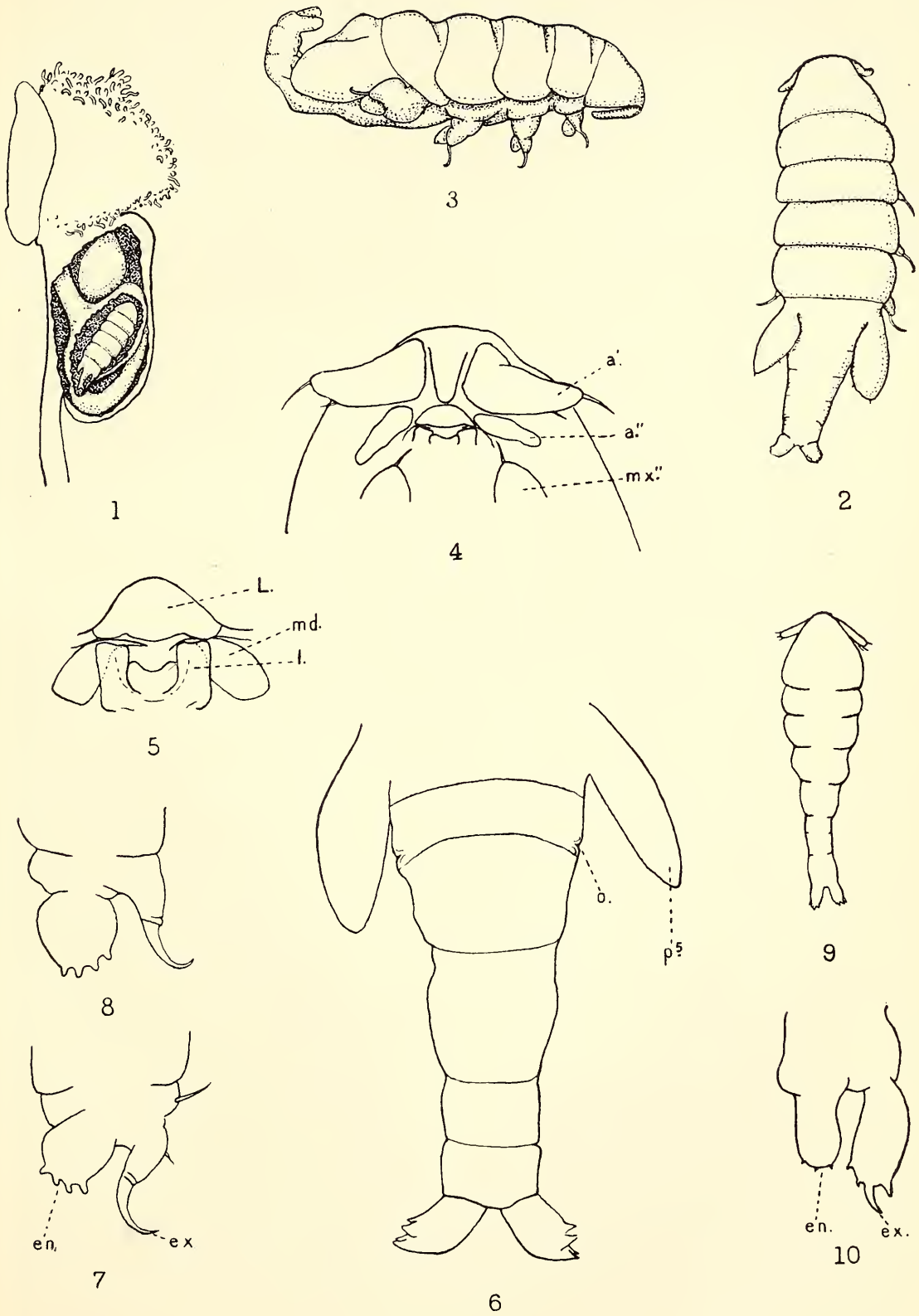
FIG.

1. Polypide of *Cephalodiscus gilchristi*, partly dissected to show the position of the parasite *Zanclopus cephalodisci* in the stomach. One of the gonads of the host is seen immediately above the stomach.
2. Adult female of *Zanclopus cephalodisci*, from above.
3. The same, from the side. The abdomen is generally bent dorsally in the position shown here.
4. Head of adult female, seen from below. *a'*, antennule, *a''*, antenna, *mx''*, second maxilla. Between the bases of the antennules is the deflexed rostrum.
5. The mouth-cone, more highly magnified. *L*, labrum or upper lip, *l*, lateral lobe of lower lip, *md*, mandible.
6. Abdominal region of adult female, from below; *p<sup>5</sup>*, fifth pair of thoracic feet, *o*, opening of oviduct.
7. Thoracic foot of second pair; *en*, endopodite, *ex*, exopodite.
8. Thoracic foot of fourth pair.
9. Larva of the earliest stage observed.
10. Third thoracic foot of same; *en*, endopodite, *ex*, exopodite.

PLATE XIX.

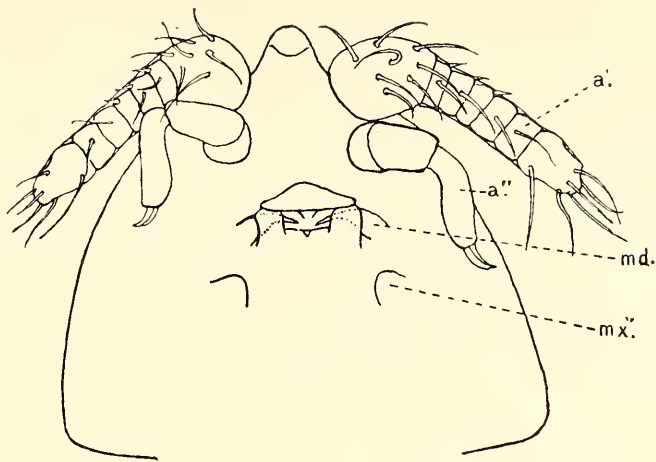
11. Male in fifth Copepodid stage, from above. Appendages omitted.
12. Head of same, from below; *a'*, antennule, showing through the thin cuticle the segmentation of the adult stage, *a''*, antenna, *md*, mandible, *mx''*, second maxilla.
13. Antenna of same.
14. Abdominal region of same, from below; *p<sup>5</sup>*, thoracic foot of fifth pair, *g.v.*, genital valve.
15. First thoracic foot of same; *en*, endopodite, *ex*, exopodite.
16. Third thoracic foot.
17. Fourth thoracic foot.



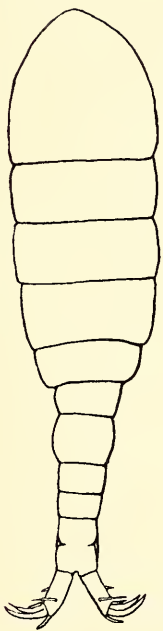


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ZANCLOPUS CEPHALODISCI.  
(Female and young).



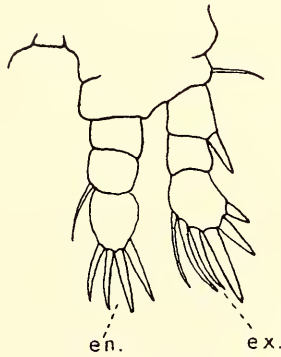
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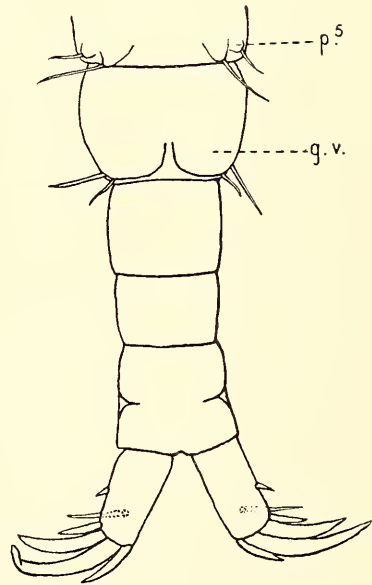
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13



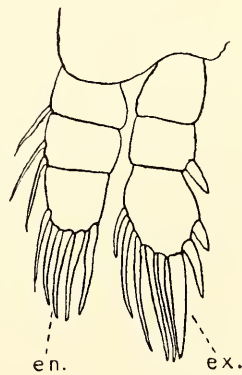
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17

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ZANCLOPUS CEPHALODISCI.  
(Male).